A NEW UPPER CRETACEOUS SPECIES OF *ISSELICRINUS* (CRINOIDEA: ARTICULATA) FROM WESTERN HAWKES BAY, NEW ZEALAND

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Abstract. A new species of crinoid, *Isselicrinus mangahouangaensis*, is described from the Upper Cretaceous Maungataniwha Sandstone, western Hawkes Bay, North Island, New Zealand. It is the first record of the genus from New Zealand and the first crinoid to be described from the Cretaceous of New Zealand. It lived in an inner shelf, marine paleoenvironment and is the remnant of a Tethyan fauna that migrated to New Zealand.

Extensive collecting at Mangahouanga Stream, western Hawkes Bay, has yielded dinosaur remains (Wiffen 1980, 1981, 1983, 1986; Wiffen & Molnar 1988; Molnar 1981; Scarlet & Molnar 1984), marine reptiles (Wiffen & Moisley 1986), Osteichthyes (Wiffen 1983), Crustacea (Glassner 1980), molluscs (Crampton 1988; Crampton & Moore 1990), ammonites, brachiopods, nautiloids, belemnites, annelids (Crampton & Moore 1990), barnacles (Buckeridge 1991), Chondrichthyes (Keyes 1977), insects (Craw & Watt 1987), and plant macrofossils (Crampton & Moore 1990). Dinoflagellates (Wilson & Moore 1988), foraminifera, and pollen (Crampton & Moore 1990) are also present. The fossil remains occur *in situ* in the sandstone matrix and in loose, locally derived, calcareous and phosphatic concretions (Moore *et al.* 1989; Crampton & Moore 1990; Issac *et al.* 1991). The locality is 100 m of stream bed at New Zealand Fossil Record localities V19/f6909 (grid reference V19/420469-421469; Fig.1). The boulders are indurated, grey, medium-grained calcareous sandstone (Moore 1986) that have been eroded out of the thick Mangataniwha Sandstone sequence exposed in the banks and bed of Mangahouanga Stream (Wiffen 1980, 1986).

GEOLOGY (Fig. 1)

The Maungataniwha Sandstone Member (of Tahora Formation; Isaac *et al.* 1991) consists of moderately indurated, poorly bedded, fine-grained, highly bioturbated, grey-mottled sandstone and lenticular shell-beds. Low angle planar cross-bedding and minor, low amplitude symmetrical ripples are also prevalent (Crampton & Moore 1990). Calcareous and phosphatic concretions and pyrite nodules are locally common in the exposed strata. The upper part of the unit is highly fossiliferous and rich in finely comminuted plant material, slightly glauconitic near the top. A coarse pebble to cobble basal conglomerate 50-60 m thick containing blocks of greywacke, ripped-up sandstone clasts and minor lenses of carbonaceous mudstone and coal interfingers with the sandstone. The marine near shore, shallow sedimentary unit was deposited during subsidence, possibly onlapping over a dissected coastal plain and/or stacking of several minor transgressive and regressive cycles (Speden 1973; Crampton & Moore 1990). The unit rests unconformably on Mesozoic greywacke of the Urewera Group and is overlain conformably by Rakauroa Mudstone (Whangai Formation).
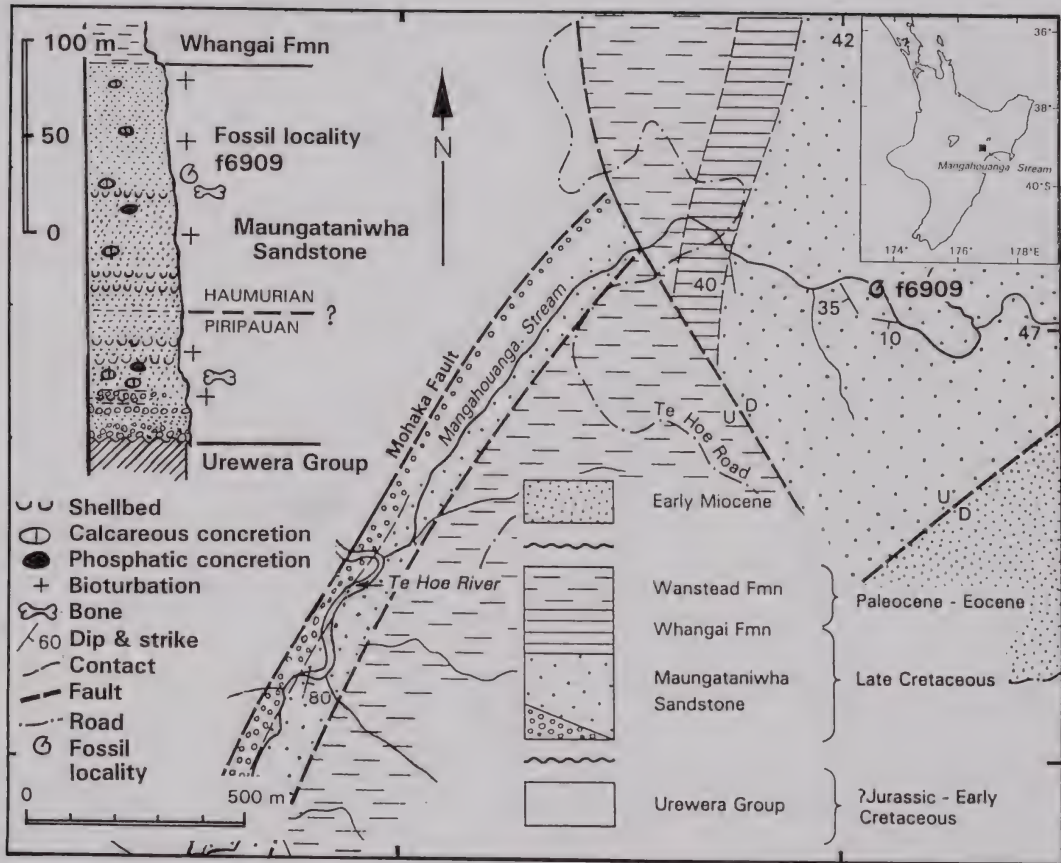
Fig. 1. Simplified geological map of Mangahouanga Stream, Te Hoe River, western Hawkes Bay, and stratigraphic column for the Mangataniwha Sandstone (modified after Crampton & Moore (1990).

SYSTEMATICS

Class	CRINOIDEA Millar, 1821
Subclass	ARTICULATA Zittel, 1879
Order	ISOCRINIDA Sieverts-Doreck, 1952
Family	ISOCRINIDAE Gislen, 1924

Articulate crinoids in which the articular face of the columnals has lanceolate to subguttiform petals surrounded by adradial and marginal crenellae. The crenellae attain their greatest length about the gradual transition from marginal to adradial position. The length of internodes is 6-17 internodals, with fewer located in the proximal region of the column. The nodals are larger than internodals with five large elliptical cirrus sockets facing outwards.

Genus	*Isselicrinus* Rovereto, 1924

Type species: *Isselicrinus insculptus* Rovereto, 1924 (by monotypy). An incompletely known species thought perhaps to be a synonym of *Pentacrinus didactylus* D'Archiac, 1846 from the Oligocene of Italy.

Isocrinidae with stellate, pentagonal, pentalobate, or cylindrical column. A gradual transition from marginal to the adradial crenellae, as in *Isocrinus,* although these are often continued in short proximal adradial ridges. Nodals possess fewer than five cirri articulated to the lower edge and directed obliquely downwards. Theca large, forming a wide bowl. Two primibrachials, the second auxiliary. The articulations I Br 1-2 and Br 1-2 are synostosial or cryptosyzygial. First pinnule is on II Br 1-2.

Isselicrinus mangahouangaensis n.sp. (Figs 2-4, 9)

MATERIAL

Holotype. GS11359/EC904 (Institute of Geological and Nuclear Sciences), infranodal columnal, only the articular face of which is preserved as an external cast. Collected by Joan Wiffen, 1973 *(in situ).*

TYPE LOCALITY AND AGE

Maungataniwha Sandstone, Mangahouanga Stream, western Hawkes Bay. New Zealand Fossil Record File number V19/f6909, V19/420469-421469, the unit being dated as late Piripauan-Haumurian (Speden 1973). Separation of these two stages has proven complicated (Warren & Speden 1977), but Crampton & Moore (1990) suggest that the upper 200-250 m of the sandstone unit (which include this site), are correlated by palynology and molluscan macrofossils as early Haumurian.

DESCRIPTION

The infranodal columnal is rounded pentagonal in transverse section. Columnar diameter is 4.1 mm in the holotype. The axial canal is narrow, pentagonal, perilumen uninterrupted, smooth, porous. Columnar articular face possesses five regular, broadly elliptical, inter-radial petals, each surrounded by 18 culmina; petal areola smooth, slightly concave, porous; two-thirds of culmina are adradial with the rest reaching the periphery. Lateral peripheral and radial crenulation is evenly joined; proximal crenellae meet in the radius at an oblique angle; distal crenellae are separated by a large, smooth, triangular radial area; radial depressions exist at the suture; crenulation forms a curved margin along the distal area of the radius and along the periphery; crenellae reach their greatest length about the transition from adradial to peripheral position. The small rudimentary crenellae near the centre are nearly perpendicular to the radius and before termination, are reduced to granules; inferred articulation between nodal and infranodal is cryptosymplectical.

ETYMOLOGY

Named after the type locality, Mangahouanga Stream.

Fig. 2. Schematic drawing of the Mangahouanga innershelf muddy-sand community (10-50 m). A = *Aequipecten* sp.; Ap = Aporrhaidae sp.; C = *Cucullaea (Cucullastis) zealandica;* Ca = *Carcharias* sp.; Cl = *Callorhynchus hectori;* D = *Dimitobelus lindsayi;* De = *Dentalium* cf. *morganianum;* E = *Entolium membranaceum;* El = elasmosaur sp.; Eo = *Eodorippe spedeni;* H = *Haumuriaegla glassneri;* I = *Inoceramus* (sensu lato) *matotorus;* Iu = *Isurus mantelli;* Is = *Isselicrinus mangahouangaensis* n.sp.; K = *Kossmaticeras (Natalites)* sp.; L = *Lingula* sp.; M = *Moanasaurus mangahouangae;* N = *Neilo cymbula;* Na = *Natica ingrata;* P = *Panopea malvernensis;* Pl = pliosaur sp.; Pt = *Pterotrigonia pseudocaudata;* Pr = Protostegidae gen. & sp. indet.; Te = *Tetragonites simplex.* No scale implied, representational only.

DISCUSSION

The gradual transition from an articular face similar to that of *Balanocrinus* (with narrow adradial ridges and short, uniform, marginal crenellae) to one similar to that of *Isocrinus* (without adradial ridges, but with elliptic or subguttiform interradial petals surrounded by radiating crenellae longest near the transition from marginal to adradial position), is inherent within a range of comparable *Isselicrinus* species. This variation is most pronounced in *I. paucicirrhus* (Fig. 6) and was the basis for Nielsen (1913) to disregard the taxonomic value of these characteristics and to unite the genera *Isocrinus* and *Balanocrinus* with *Pentacrinus*. Ontogeny in *Isselicrinus* columnals is reflected in a change from an *Isocrinus* articular face pattern to that of *Balanocrinus*; from a more or less pentalobate columnal outline to a more or less circular one (Rasmussen 1961).

Bather (1917) and Sieverts-Doreck (1944) studied *Isselicrinus* species, at the time deferred to *Balanocrinus*. Bather postulated that the *Balanocrinus* morphology arose several times from that of *Isocrinus* between the Triassic and Oligocene, stating that it thus did not constitute a homogeneous monophyletic genus. Bather further suggested that some species of *Balanocrinus,* if accepted as polyphyletic, should perhaps be regarded as a subgenus of *Isocrinus.* Rasmussen (1953) established a new genus, *Lipocrinus,* by separating this uniform and natural group existing within *Balanocrinus.* Rasmussen (1954) however, later synonymised the genus *Lipocrinus* with *Isselicrinus* even though this genus, without affecting the priority of the generic name, was established on the misinterpretation of a damaged column fragment (Rasmussen 1961). Rasmussen (1961) also stated that "separation of the species must generally be based on the form of the columnals, which alone are normally known." Historically, species of *Isselicrinus* are usually separated and described only by small differences in relative as well as absolute dimensions and the morphological plan of the articular face. Since the theca, brachials, pinnules and form of the column is unknown, only the plan of the articular face is a distinguishable feature in *Isselicrinus mangahouangaensis.*

0   5 mm
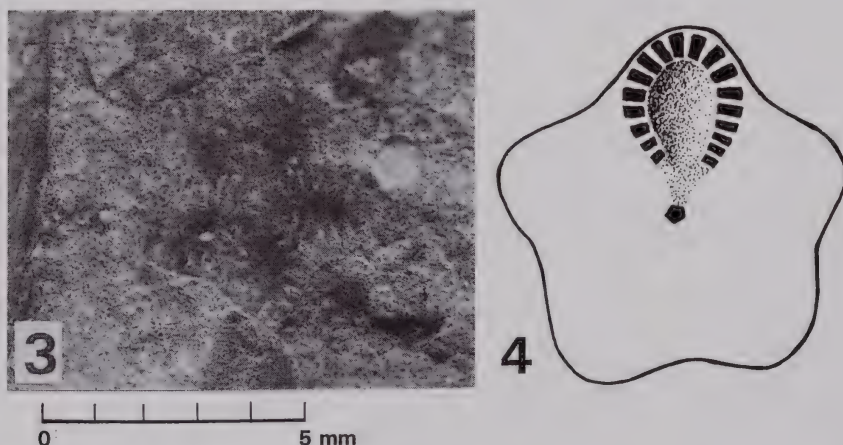
Figs 3-4. *Isselicrinus mangahouangaensis* n. sp., Mangahouanga Stream, western Hawkes Bay. 3. Proximal view of the infranodal columnal articular face of the holotype EC904. 4. Infranodal columnal articular face diagram of the broad convex petal areolae, number of culmina, curved crenulation pattern and pentagonal axial canal. Diagrammatic only, no scale implied.

Earlier fossil lists from Mangahouanga Stream have recorded crinoid columnals but misplacement and the inaccessibility of private collections has precluded examination of these specimens.

The following Cretaceous and Tertiary *Isselicrinus* species were compared with *I. mangahouangaensis: I. stelliferus* (Hagenow, 1840); *I. peroni* (Loriol, 1893); *I. daniensis* (Valette, 1932); *I. groenlandicus* Rasmussen, 1961; *I. tibiensis* (Dupuy de Lome & Revilla, 1956); *I. dixoni* (Ooster, 1870); *I. bryani* (Gabbi, 1876); *I. paucicirrhus* (Nielsen, 1913); *I. buchii* (Romer, 1840); *I. africanus* (Loriol, 1893); *I. sundaicus* (Wanner, 1938); *I. lorioli* (Noell, 1900); *I. haitiensis* (Springer, 1925); *I. diaboli* (Bayan, 1908); *I. cubensis* (Valette in Roig, 1926); *I. subbasaltiformis* (Sowerby in Weatherell, 1837); *I. insculptus* Roverto, 1914; *I. inkermanensis* (Loriol, 1879); *I. didactylus* (D'Archiac, 1846); *I. dallonii* (Termier & Termier, 1949). From these, four Cretaceous species with columnal articular faces exhibiting morphological affinities have been chosen for detailed comparison to *I. mangahouangaensis* (Figs 5-8).

The columnals of the four comparative Cretaceous species *Isselicrinus stelliferus, I. paucicirrhus, I. peroni* and *I. bryani* are all larger than that of *I. mangahouangaensis* (Table 1). Unlike the rounded pentagonal infranodal columnal of *I. mangahouangaensis*, rare infranodal columnals of Maastrichtan *I. stelliferus* from the White Chalk of Kugan, Mon, Germany, and other European localities, are stellate, with sharp, straight edges and are rather high (1.2-1.6 mm). The articular face of the infranodal columnal of *I. mangahouangaensis*, as in all isocrinids, is characterised by five interradial petals. In *I. mangahouangaensis*, these are broadly elliptical and each interradial petal has 10 short crenellae along the periphery and 4 along each radius; a section totals 18 culmina. In contrast, the articular face of *I. stelliferus* has interradial petals that are narrow and elliptical, with each section having 4-14 short crenellae along the periphery and from 0-2 along each radius; a total of 8-18 culmina. An indistinct adradial ridge divided by a radial furrow exists along the radius of *I. stelliferus* but is absent in *I. mangahouangaensis*. Both species exhibit petals with a distinctly porous areola that continues around the axial canal, which in *I. stelliferus* is circular but pentagonal in *I.*

Table 1. Comparative maximum measurements (mm) and meristics of the columnals of: *Isselicrinus mangahouangaensis* (A); *I. stelliferus* (B); *I. paucicirrhus* (C); *I. peroni* (D) and *I. bryani* (E).

Isselicrinus spp.	A	B	C	D	E
Columnal diameter	4.1	4.6	7.0	7.0	11.2
Interradius length	1.9	2.1	4.0	3.2	4.1
Radius length	1.1	1.5	3.7	3.0	3.9
Columnal height	-	1.6	2.2	2.6	0.9
Mean no. of peripheral crenellae per section	10	14	12	12	10
Mean no. of radial crenellae per section	4	2	5	10	1

mangahouangaensis. The articulation between nodal and infranodal is almost smooth, cryptosymplectical in *I. stelliferus* and inferred to be similar in *I. mangahouangaensis*. No evidence of the number of cirri that have been articulated to the nodal are seen on infranodals of either *I. stelliferus* or *I. mangahouangaensis*.

Common lower Danian macrofossil internodal columnals of *Isselicrinus paucicirrhus* in Denmark and Sweden, are, by comparison, pentalobate and of similar height to *I. stelliferus* (0.9-2.3 mm). The internodal columnal articular face of *I. paucicirrhus* is characterised by five elongate, narrow, elliptical petals that have 12 short crenullae along the periphery and 5 along each radius and a total of 22 culmina. Although total culmina number the same per section as in *I. mangahouangaensis* and *I. stelliferus* the culmina petal pattern varies considerably from either. Both *I. paucicirrhus* and *I. mangahouangaensis* show the porous structure of the petals. Unlike *I. mangahouangaensis*, in *I. paucicirrhus* an indistinct double ridge along the radius is divided by a radial furrow. A further disparity between *I. mangahouangaensis* and *I. paucicirrhus* is the adradial ridge in *I.paucicirrhus* which is succeeded near the periphery by crenullae which form a curved margin along the distal part of the radius and periphery. The small rudimentary crenullae toward the axial canal are perpendicular to the radius as in *I. mangahouangaensis*, but unlike *I. mangahouangaensis*, the limits of the adradial ridges in *I. paucicirrhus* are parallel or outwardly diverging then soon disappear and are only then succeeded by crenellae. *I. mangahouangaensis* has no radial furrows or inferred radial pores whereas in *I. paucicirrhus* radial furrows continue to the periphery where they form a radial pore in the column suture. A smooth radial area exists in *I. mangahouangaensis* but not in *I. paucicirrhus*. *I. mangahouangaensis* and *I. paucicirrhus* possess pentagonal and narrow subpentagonal axial canals respectively. The articulation between nodal and infranodal in *I. paucicirrhus* is smooth synostosial or faint cryptosymplectical; *I. mangahouangaensis* is inferred cryptosymplectical only. *I. stelliferus, I. paucicirrhus,* and *I. mangahouangaensis*, as in *Isocrinus,* all have crenellae with their greatest length near the radius, are reduced at the periphery and are separated from the column edge in the infranodal by a narrow, curved, smooth margin.

Isselicrinus peroni infranodal columnals are rare and are known only from the Senonian and Danian of Tunisia are distinctly pentagonal with rounded edges and vary in height (1.3-2.6 mm). *I. peroni* is the most similar species to *I. mangahouangaensis*. The articular face of *I. peroni* (with subguttiform interradial petals) is up to 7 mm in diameter and possesses a suture that is non-crenulate. Like *I. mangahouangaensis*, the axial canal in *I. peroni* is narrow, pentagonal. Interradial petals with porous areolae in *I. peroni*, differ from *I. mangahouangaensis* in that they are narrow and not broad, and possess more culmina per section (22 as distinct from 18) than in *I. mangahouangaensis*. In both *I. mangahouangaensis* and *I. peroni*, proximal crenellae meet in the radius at an oblique angle, but more distal crenellae are separated by a large smooth triangular radial area; crenulation reaches the edge of the columnal in both species only in the interradial angle. Both *I. mangahouangaensis* and *I. peroni* possess areolae around the axial canal that are porous, however, this area is proportionately larger in *I. mangahouangaensis* than in *I. peroni* extending radially further outward. This morphological difference is possibly due to the reduced number of culmina per section. As in *I. mangahouangaensis*, crenulation in *I. peroni* reaches the edge of the columnal only in the interradial angle; there is no evidence of radial pores in the suture of either species.

Danian internodal columnals of *Isselicrinus bryani*, known solely from New Jersey,
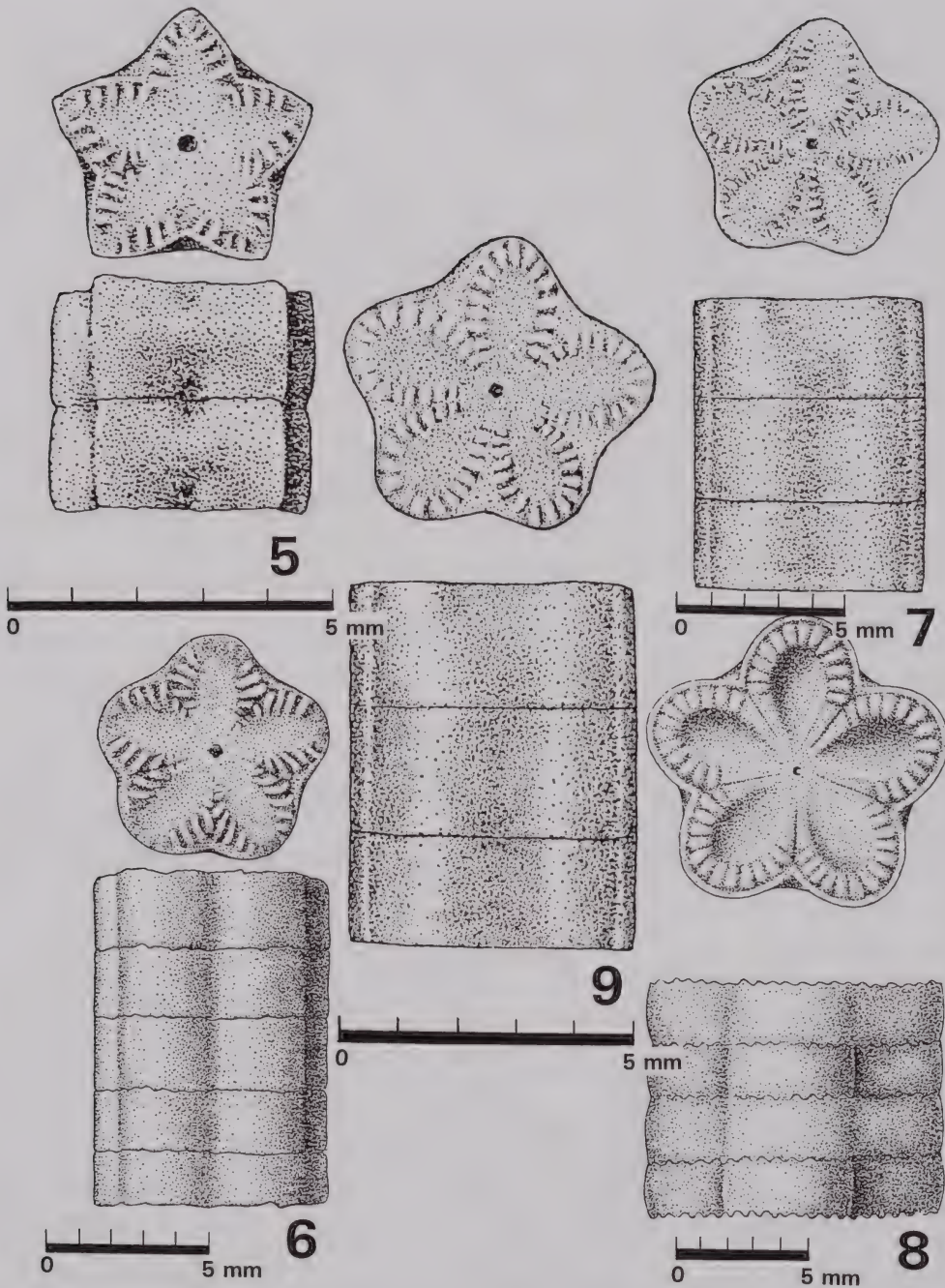
Figs 5-9. Proximal articular faces and lateral views of pluricolumnal stems of *Isselicrinus* spp.
5. *I. stelliferus* (infranodal), Lower Maastrichtian, White Chalk of Rugen, Mon, Germany
(neotype). 6. *I. paucicirrhus* (internodal), Lower Danian, Kagstrup, Denmark (lectotype). 7. *I.
peroni* (infranodal), Senonian, Guelaat-es-snam, Tunisia (lectotype). 8. *I. bryani* (internodal),
Danian, Vincetown Limesand, New Jersey, U.S.A. (holotype). 9. *I. mangahouangaensis* n. sp.
(reconstructed infranodal from holotype). (Figs 5-8 from Rasmussen (1961)).

United States of America, are rounded pentalobate with a low profile (O.5-0.9 mm). *I. bryani*, like *I. mangahouangaensis* has wide subguttiform petals, and short, rather uniform crenellae. The difference between the two species other than the larger size, is the presence of radial ridges in *I. bryani* and only 13 culmina (10 along the periphery and one along each radius) within each section. *I. mangahouangaensis* may not have a crenulate suture, but *I. bryani* does.

The infranodal columnal of *Isselicrinus mangahouangaensis* is distinctly different from all other species of the genus because of a differing articular face, interradial petal pattern, number and orientation of culmina, large areola area surrounding the axial canal and large triangular radial area. The rarity of *I. mangahouangaensis* ossicles and absence of pluricolumnals does not suggest death *in situ*. However, the articular face of the holotype is relatively sharp in detail, suggesting little transportation in a low-energy, marine environment (Speden 1973). Since all Isocrinida enjoyed a wide environmental range in the early Cretaceous, the presence of another benthic, semi-sessile, articulate crinoid in shallow water near shore facies proves that isocrinids were prevalent in this New Zealand paleoenvironment during both the Mesozoic and Cenozoic (Eagle 1993; Eagle & Hayward 1993). Because of similarities to European *Isselicrinus* species, it is suggested that *I. mangahouangaensis* is a Mesozoic remnant of a Tethyan fauna that migrated to New Zealand before or during the Cretaceous.

FAUNAL ASSOCIATIONS AND PALEOENVIRONMENT (Fig. 2)

Crampton & Moore (1990) list the fossil macrofauna from the Maungataniwha Sandstone in the region of Mangahouanga Stream. The fauna is that of an upper Cretaceous fine grained, bioturbated, muddy-sandy bottom and a representative selection is illustrated (Fig. 2). The assemblage includes a high proportion of detritus-feeding and burrowing taxa diagnostic of a near shore, low energy environment of 10-50 m, i.e. innershelf. Crampton & Moore (1990) state: "inferred feeding habits and substrate niches of the fauna, and the abundance of adult and juvenile marine reptiles, suggest an estuary, bay or inlet setting".

Inoceramus (sensu lato) *matotorus, I.* (s.l.) *australis* and *I.* (s.l.) *pacificus* were particularly common living in clusters attached by byssal threads to each other and to shell debris. Infaunal elements include the deep burrower *Panopea malvernensis,* the costate *Pterotrigonia pseudocaudata,* the asiphonate *Cucullaea (Cucullastis) zealandica* and the siphonate *Neilo cymbula.* The epifaunal pectinid bivalve *Aequipecten* is also present with the free-living, perhaps occasionally swimming, smooth, sub-circular *Entolium membranaceum.* Gastropods seem not to have been as abundant as bivalves in this biotope; *Turbo* was probably an algal grazer, Aporrhaidae are ciliary feeders on fine deposits and *Natica ingrata* a carnivore. Infaunal scaphopods are represented by *Dentalium* cf. *morganianum.* The only brachiopod known from this community is a burrowing *Lingula* sp. *Isselicrinus mangahouangaensis* n. sp. is a typical semi-sessile, benthic isocrinid which probably lived attached to any hard substrate where minimal currents provided both food and oxygen to the passive filter feeder. Epifaunal decapods such as *Eodorippe spedeni* and *Haumuriaegla glaessneri* existed on the soft substrate. Intensive bioturbation, with trace-fossils such as knobbly mud-lined *Ophiomorpha, Planolites* oriented oblique to bedding, and *Chondrites,* indicate the presence of diverse arthropods and polychaetes.

A diverse nektonic carnivore fauna consisting of the osteichthyan *Pachyrhizodus caninis,* many cephalopods (the nautiloid *Cimomia* sp., and several genera of ammonites

including the normally coiled *Tetragonites simplex, Kossmaticeras (Natalites)* sp. and *Anagaudryceras subsacya; Dimitobelus hectori, D. lindsayi,* and *D. ongleyi* representing the Belemnoidea) existed in the biotope. Toothless, beaked protostegid sea turtles paddled in the vicinity. Chondrichthyan fauna such as *Carcharias* sp., *Isurus mantelli* and *Callorhynchus hectori* may have made regular incursions through the biotope. Marine saurians such as *Moanasaurus mangahouangae,* Elasmosauridae sp. and Pliosauridae sp. were also vagrant occupants. Remnants of Boreal genera merge into a Tethyan association within this southern Pacific assemblage.

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